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FALLS RIVER REDEVELOPMENT
ENVIRONMENTAL REVIEW OF
RESERVOIR CLEARING OPTIONS

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FALLS RIVER REDEVELOPMENT

ENVIRONMENTAL REVIEW OF RESERVOIR CLEARING OPTIONS

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NOTE

Imperial units are retained for elevation throughout this report in order to maintain consistency with reference sources and clearing criteria which preceded metrification.

The following approximate conversions apply:

Feet	Metres
295	90
303	92
305	93
308	94
313	95
360	110

SECTION 1.0 - SUMMARY

As part of an approved redevelopment project, the B.C. Utilities Commission directed B.C. Hydro to clear the dead and dying trees from the storage impoundment of the Falls River hydroelectric generating plant. The environmental implications of alternative methods of meeting this directive are reviewed in this report. The benefits identified from an environmental viewpoint do not appear to warrant the clearing. Net environmental effects of all clearing operations appear to be slightly negative. Justification of reservoir clearing would have to be based on some other criteria.

Aquatic resources have been examined from three perspectives: water quality, benthic production and fish. Present reservoir productivity and existing fish populations are low. All clearing options are expected to have detrimental effects on each of these aspects of the aquatic ecology.

The forest resource surrounding the reservoir is composed primarily of mature to decadent conifers. None of the clearing options is expected to have any major beneficial or detrimental effects on this resource. The El. 313 clearing option might slightly hasten the harvest of about 100 ha of merchantable timber in the inflow regions of the reservoir.

Waterfowl use of the reservoir is minor and is mainly limited to feeding by Canada geese on the upstream reservoir margin. At least one pair each of osprey and loon nest and raise their young on the reservoir. All clearing options would have a slight detrimental effect on the wildlife resource should these species abandon the reservoir.

Recreational capability and use are rated as low. Capability is presently limited by the standing timber and floating debris whereas use is restricted by remoteness and abundance of alternate sites offering superior or comparable recreation experiences. All clearing

options would improve the capability although the the El. 313 option would create an unnatural shoreline devoid of mature trees. Use would probably not increase concommitant with improved capability.

SECTION 2.0 - BACKGROUND AND HISTORY

In December 1980 the Minister of Energy, Mines and Petroleum Resources directed the British Columbia Utilities Commission (hereafter the Commission) to hold a hearing to examine B.C. Hydro's application to redevelop and expand, from 7 MW to 22 MW, the small hydroelectric facility on Falls River. This small isolated installation is located some 33 air miles southeast of Prince Rupert. The hearing took place in Prince Rupert and Vancouver over a 7-day period between 5 May and 29 May 1981.

By Commission Order No. C-3-81 dated 30 July 1981, the Commission approved B.C. Hydro's application and issued a Certificate of Public Convenience and Necessity to permit the redevelopment (B.C. Utilities Commission 1981). This approval was subject to compliance with three specific directives one of which was: "The Applicant will undertake to remove the dead or dying trees currently standing in the reservoir and forebay, as part of the approved redevelopment project".

The nature, extent and methods of such clearing were not specified in the directive but would have different environmental effects and social costs. B.C. Hydro therefore undertook a study to determine the most suitable methods and extent of clearing which would meet the directive to remove dead or dying trees. The study, initiated in January 1982, was to focus on effects of various clearing alternatives on aquatic, forestry, wildlife and recreational values. Specialists contributing to this study were D. Maxwell (water quality), R. Ferguson and A. Redenbach (fish), R. Becker (forestry), R. Bradley (wildlife), and P. Juurand (recreation).

The history of changes in the reservoir level has significantly affected trees along the shoreline and future operating levels would further affect survival of a narrow band of trees along the reservoir margin. The existing dam, completed in 1930, was built to El. 305 feet

(local datum) (B.C. Hydro 1980a). Initial full supply level was at the spillway crest level at El. 295. Timber flashboards were subsequently installed on top of the spillway crest to raise full supply level to El. 303.0 (B.C. Hydro 1978). For the period 1970 to 1977 the reservoir was operated with flashboards setting the full supply level at El. 305 (B.C. Hydro 1980b). The high water during this period, plus effects of flood levels above the present spillway crest, have killed all shoreline trees to El. 305. After 1978 the full supply level was returned to El. 303.0.

The operating regime proposed for the redevelopment is essentially the same as that used during 1970 to 1977. However, occasional flashfloods of short duration could cause slightly higher water levels than those recorded during the preceeding 7-year period.

SECTION 3.0 - RESERVOIR RESOURCES

This section provides a brief description of the aquatic, forest, wildlife and recreational values of the reservoir area. Although the field observations took place over a 1-week period during July, natural seasonal variations of the resources are assessed in the analysis. All authors are confident that the period observed provided sufficient information to support the conclusions reached.

3.1 AQUATIC RESOURCES

(a) Water Quality

Available water quality data are limited to those provided in a report by H.M. Larratt Aquatic Consultants Ltd. (1983) and are summarized here. Temperature, dissolved oxygen, and pH profiles were measured in July 1982 at six stations. Water quality samples were collected at the Big Falls Creek inlet and the Falls River outlet. At the outlet both the hypolimnion and epilimnion were sampled.

Bathymetry measurements showed that the small reservoir has extensive shallow areas. The maximum depth in the pool just above the dam is 12.8 m, surrounded by a steeply sloping bottom. The only other deep area is the old stream channel which curves through the reservoir. East of the constricting narrows, all depths are less than 7 m.

In July a consistent and distinct thermocline at 2.3 m separated a shallow epilimnion (15°C) and the oxygen-rich hypolimnion (12°C). The pH averaged 5.8, which is strongly acidic for a B.C. lake. The low hardness (3 to 4 mg $CaCO_3$/L) and low alkalinity (3 mg $CaCO_3$/L) are consistent with the acidic pH. The total nitrogen

(0.02 to 0.07 mg/L) and total phosphorus (<0.005 mg/L) levels showed insignificant change due to short retention time in the reservoir. Organic nitrogen increased marginally from 0.015 to 0.055 mg/L. Nitrate concentrations, although consistently low, increased via retention from 0.007 to 0.015 mg/L.

Scuba diving observations made by H.M. Larratt Aquatic Consultants Ltd. indicate that considerable sediment load is deposited on the reservoir bottom. The original stream channel has a hard-packed sandy substrate whereas most of the reservoir has a sand and silt substrate with woody fragments throughout. Fine glacial flour is still suspended in the water at the reservoir outlet.

In summary, the reservoir generally has high dissolved oxygen levels, low nutrient levels, and moderate to low hardness. The reservoir is small, shallow and the retention time is in the order of a few days.

(b) Benthic Production

Fish in the reservoir are totally dependant upon food which is either produced within the reservoir or drifts in from tributary streams or land sources. Since the drift source would be unaffected by reservoir clearing, a strong emphasis was placed upon primary and secondary production within the reservoir. A separate consultant study was carried out to assess factors influencing this production and the following conclusions are extracted from that study (H.M. Larratt Aquatic Consultants Ltd. 1983).

The Falls River reservoir is oligotrophic (low productivity due to low nutrient levels). The rapid flushing rate results in a large, cold hypolimnion. The average pH of 5.8 is strongly acidic. The submerged timber has a slow decomposition rate and therefore causes neither a biochemical oxygen demand nor a detectable nutrient contribution. Plankton and aufwuchs (organisms attached

to but not penetrating a substrate) on timber and on sediment were the three primary producer communities. Only one submerged weedbed has been located but a 2.4 m reduction in reservoir level 10 months before the field work may have eliminated other such beds over large exposed mudflats at the upstream end of the reservoir. Consequently, the littoral macrophyte community may have figured more prominently prior to the water level reduction.

The submerged standing wood is still in good condition after 50 years. The peripheral 1 cm of the wood surface is soft but the interiors of the trees are sound wood. Only the weathered and periodically exposed wood is decaying. Timber aufwuchs communities are important in both biomass production and species present so the submerged wood is currently enhancing production. Several groups of preferred fish food organisms associated with filamentous algae patches are only found in the timber aufwuchs.

Big Falls Creek carries a considerable sediment load which deposits on the reservoir bottom. The original river channel is still evident and represents the only portion of the reservoir bottom which does not have wood debris scattered throughout the substrate. Fine glacial flour suspended in the water limits light penetration even at the reservoir outlet. The sediment aufwuchs community with the photic zone of the extensive shallow areas produces species important to invertebrate grazers. The strictly benthic molluscs found here are an important food item for the Dolly Varden char.

(c) Fish

Five gill net stations were established to assess species composition and relative abundance of fish populations in the Falls River reservoir during 26 to 29 July 1982. Gill net gangs were set approximately parallel to shore at selected depth contours at each station (Fig. 1). Two nets were used, one consisting of three mesh sizes (28, 38 and 51 mm) and a second net

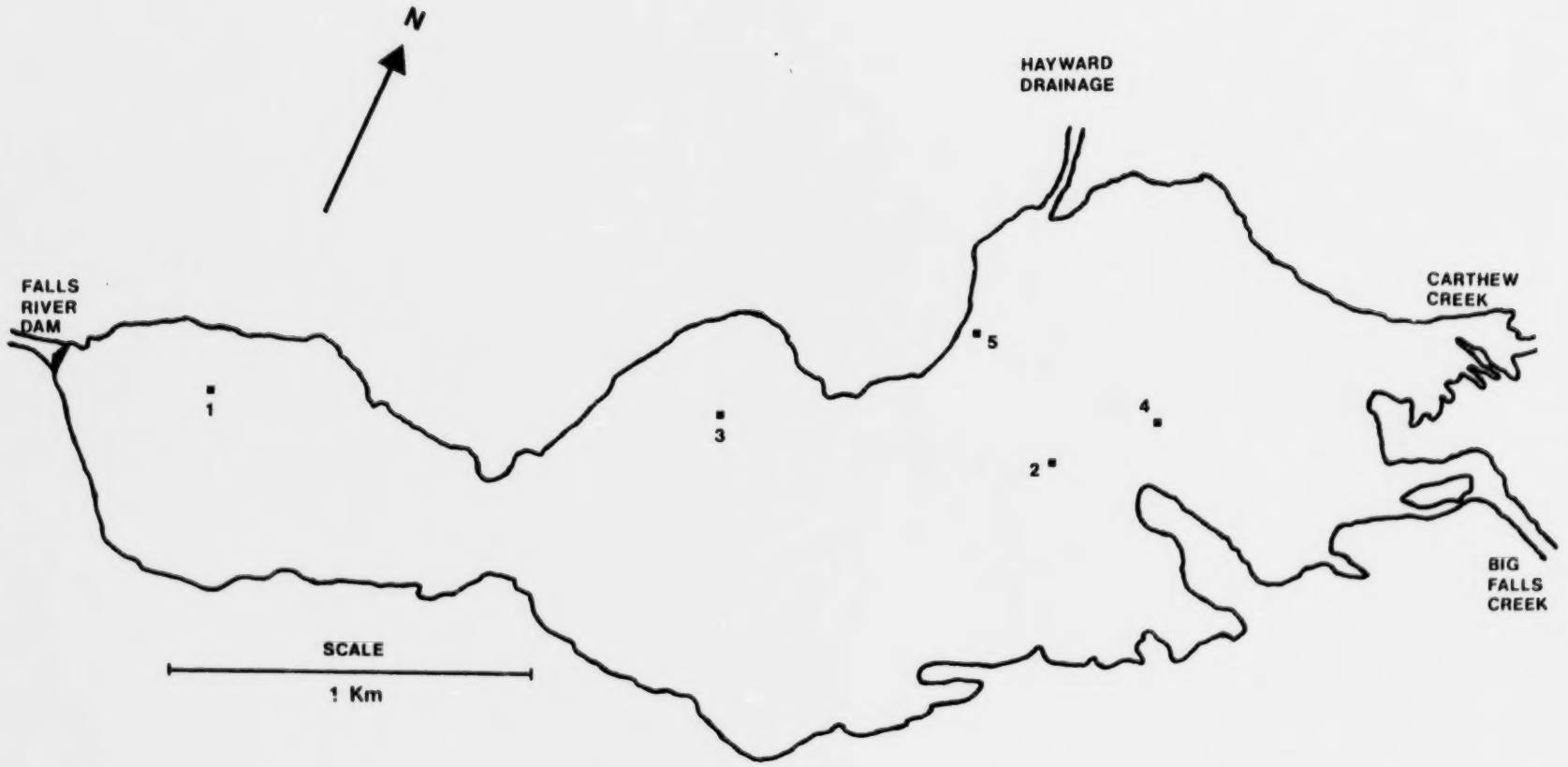


Figure 1 - Location of Gill Net Stations in Falls River Reservoir

made of two mesh sizes (38 and 51 mm). Nets were set at the 2 to 3 m contour and fished most of the water column. Nets were usually set in the afternoon and retrieved the next morning. However at stations 2 and 4, nets were set one morning and examined the following morning. Net sets averaged 17 hours at each of the five stations.

Netting efforts resulted in catches of 0.3 fish per hour for the two salmonid species, namely cutthroat trout and Dolly Varden char, which inhabit the reservoir. A total of 26 fish were taken of which 12 were cutthroat, the remainder being Dolly Varden. The catch from each gang and each mesh size was recorded separately.

Fish were identified to species and the fork length of each fish measured to the nearest 5 mm and weighed to the nearest 10 g. For aging purposes, scale samples were taken from the cutthroat trout, whereas otoliths and scales were removed from the Dolly Varden char. The sex and sexual development of each fish was ascertained by dissection.

Cutthroat trout were netted at all stations with the exception of station 4 where no fish were captured. Dolly Varden were only netted at stations 3 and 5 (Table 3-1). The gillnet sample of sport-fish (cutthroat and Dolly Varden) was sufficient for comparing productivity although small sizes of these species and nongame species would have been missed. In such a small reservoir a larger sample could cause a serious reduction of the fish population.

Cutthroat trout ages range from 3+ to 5+ years while Dolly Varden char ages were limited to 2+ and 3+ years. The greatest proportion of both species was in the 3+ year class.

Mean lengths for the 3+, 4+ and 5+ year cutthroat trout are 200, 268 and 320 mm respectively (Table 3-2). Mean weights for the same groups are 98, 198 and 380 g. Dolly Varden char in the 2+

TABLE 3-1

GILL NETTING EFFORT, NUMBERS AND SPECIES OF FISH
NETTED IN FALLS RIVER RESERVOIR (26 to 29 July 1982)

Date	Net In	Net Out	Hours	Site	Species	Number Caught	Comments
07/26/82 07/27/82	1530	1000	18.5	1	Cutthroat	1	Net #1 sfc temp. 14°C
07/27/82 07/28/82	1100	0700	20.0	2	Cutthroat	6	Net #1 sfc temp. 12°C
07/27/82 07/28/82	2130	0830	11.0	3	Cutthroat Dolly Varden	2 13	Net #2
07/28/82 07/29/82	0730	0800	24.5	4	-	0	Net #1 sfc temp. 10°C
07/28/82 07/29/82	2130	0800	10.5	5	Cutthroat Dolly Varden	3 1	Net #2 sfc temp. 18°C
			84.5			26	

TABLE 3-2

LENGTHS AND WEIGHTS OF CUTTHROAT TROUT AND DOLLY VARDEN CHAR AGE CLASSES

	Species							
	Cutthroat Trout				Dolly Varden Char			
	Length (mm)		Weight (gm)		Length (mm)		Weight (gm)	
Age	Mean	Range	Mean	Range	Mean	Range	Mean	Range
2+					176	165-185	75	70-80
3+	200	180-225	98	60-140	215	200-240	133	90-190
4+	268	255-280	198	180-220				
5+	320	320	380	380				

and 3+ ages averaged 176 and 215 mm in length and weighed 75 and 133 g respectively. The age class frequencies in relation to the lengths and weights are shown in Fig. 2.

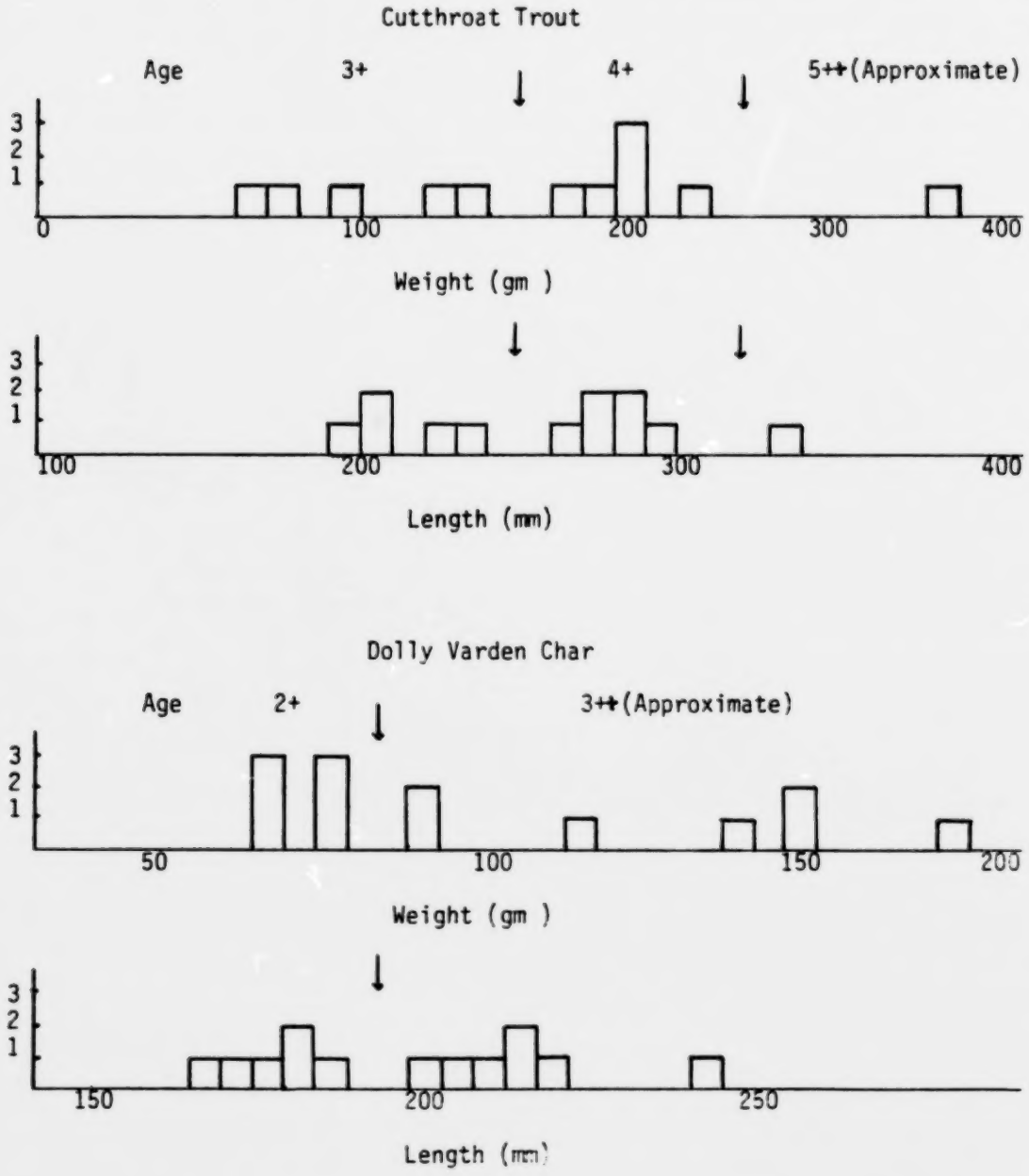
The female to male ratios for cutthroat trout and Dolly Varden were 5:1 and 2:3 respectively. One Dolly Varden female and one male of each species had spawned in the previous season. The remaining fish of determinable sex would have spawned during the next spawning season. Six cutthroat and three Dolly Varden char were juveniles of undeterminable sex.

A measure of productivity was obtained by comparing the sports fish from Falls River reservoir with those of similar age occurring in other lakes and streams in B.C. and Alberta. Cutthroat in the reservoir are small in comparison to average size in other lakes and streams (Carlander, 1969). Falls River trout ranged from 50 to 75 percent of the averages of same age fish whereas weights ranged from 13 to 65 percent (Table 3-2). The most notable difference in weight occurs in the 3+ age class where trout in the reservoir are more similar to stream reared fish than lake reared. Dolly Varden lengths and weights were also below average. Lengths for each age class are about 20 percent less than average; weights are about 35 percent less. There is little overlap in length or weight ranges for either species with the range in means recorded by Carlander (1969).

Analyses of stomach contents from cutthroat and Dolly Varden in the reservoir indicate that the majority of food items are associated with the timber and sediment aufwuchs communities (H.M. Larratt Aquatic Consultants Ltd., 1983). Cutthroat stomachs contained mainly midge and mayfly larvae (60 percent) which were associated with algal mats. Blackfly and caddis fly larvae, found in the macroinvertebrate drift, represented 28 percent of the organisms ingested. The remaining food items consisted of miscellaneous stonefly, caddis fly and beetle larvae and benthic molluscs. Dolly Varden were found to feed largely (92 percent) on

FIGURE 2

LENGTH, WEIGHT AND AGE CLASSES OF CUTTHROAT TROUT AND DOLLY VARDEN CHAR NETTED IN FALLS RIVER RESERVOIR (26 to 29 July 1982)



organisms associated with the timber aufwuchs (midges and mayflies) and sediment aufwuchs (molluscs and sideswimmers) communities. Of those organisms consumed by Dolly Varden, 50 percent were associated only with the timber aufwuchs community. Miscellaneous species of fly, caddis fly and mayfly were of lesser importance.

Primary and secondary production as well as the structure of the aquatic communities in the reservoir are limited and are determined by retention time and available nutrients (H.M. Larratt Aquatic Consultants, 1983). Biomass production, primarily limited to the timber and sediment aufwuchs communities, was estimated to be 87.9 and 12.0 percent respectively while plankton production was 0.05 percent. The ratio of production is probably related to the nature of the habitat provided by the standing trees and reservoir sediment characteristics.

In conclusion, primary production associated with the timber aufwuchs community contributes a major portion of the biomass that is consumed by invertebrates. These invertebrates are either directly consumed by fish or pass through additional trophic levels of carnivorous invertebrates before being eaten by fish. Both salmonid species utilized, to a large extent, invertebrates associated with the timber aufwuchs community.

3.2 FOREST RESOURCES

Falls River reservoir, shown as Big Falls Lake on the B.C. forest cover maps, is surrounded by forest types common in the wet maritime subzone of the Coastal Western Hemlock Biogeoclimatic Zone. The dominant tree species are western red-cedar, cypress (yellow-cedar), western hemlock, balsam (Pacific silver fir), and Sitka spruce. Except for the flat-bottomed valleys at the northern end of Big Falls Lake where Carthew and Big Falls creeks and the drainage creek from Hayward Lake enter the reservoir, the forest types grow on steep shoreline sites.

The forest types here form a fringe about 500 m wide below a non-forested alpine area. Under present forest cover classification and mapping procedures, these fringe types would be classified as unharvestable under Environmental Protection Area problem categories of soil and steepness, forest regeneration, inoperable because of access, or severe snow chutes and avalanches.

All of the timber stands surrounding Big Falls Lake are classified as mature, i.e. over 251 years old. Tree heights are less than 30 m on the steep shoreline sites, 30 to 40 m on the valley floor leading to Hayward Lake, and up to 55 m for the Sitka spruce and hemlock trees in the Carthew and Big Falls Creek valleys. All forest types are fully stocked with 76 or more trees per hectare. Growing sites are poor for all of the steep slope sites, medium in the Hayward Lake valley, and good in the Carthew and Big Falls Creek valleys. Average timber volumes per hectare, shown in Table 5-1, range from 380 to 980 m^3/ha.

The forests surrounding Big Falls Lake are in Region 64 and Compartment 41 of the Prince Rupert Forest Region. They are in the Skeena Timber Supply Block of the North Coast Timber Supply Area. None of the snags standing in the reservoir waters or fallen on the shoreline areas are of salvageable value. Only live trees between El. 305 and 313 that might be cleared under Alternatives B or C of the clearing criteria (Appendix A), would be of commercial value.

3.3 WILDLIFE

A wildlife biologist spent 3 days on the reservoir in late July 1982 to generally assess use of the area. The main objective was to assess the suitability of the standing snags as nest sites for hole nesting waterfowl or other birds.

The Falls River reservoir is not good quality waterfowl habitat. Most of the shoreline is steep and rocky and there is limited macrophyte production. Canada geese use the mudflats at the east end of the

reservoir as a spring staging area. Evidence of grazing, root-mining, and droppings occurred on almost every sand bar or mudflat. A female common merganser was observed with seven chicks in the inflowing Big Falls Creek.

Hundreds of trees and snags in the reservoir were searched with binoculars to determine the availability of cavities suitable for hole-nesting birds. No cavities were found. A low insect infestation rate or the unsuitability of woodpecker cover over the reservoir may have precluded the development of new holes since the trees died. Cavities which may have existed in the crowns of living trees would have been removed when the crowns broke off.

At least one pair of common loon resides on the lake as adults and chicks were observed. This pair nested on a floating mass of sphagnum, cotton grass and sundew near the central island (Fig. 3). A loon frequently called at the west end of the lake but it was not determined if this caller was one of the pair. A pair of osprey have a nest on top of a snag offshore of the mouth of Carthew Creek (Fig. 3). No chick was evident in this nest but both parents screeched loudly and flew back and forth to nearby perches whenever observers approached the nest. One subadult bald eagle was observed flying and perching over the reservoir.

Other bird species observed during the field trip included rough-winged and barn swallows which were feeding on insects flying over the reservoir and mudflats at the east end.

In the bog areas, sand bars, and dried mud, upstream of the reservoir, tracks and other signs indicate the presence of black and grizzly bear, wolf, moose, and deer. A mink was seen swimming and climbing out on logs near the mouth of Carthew Creek.

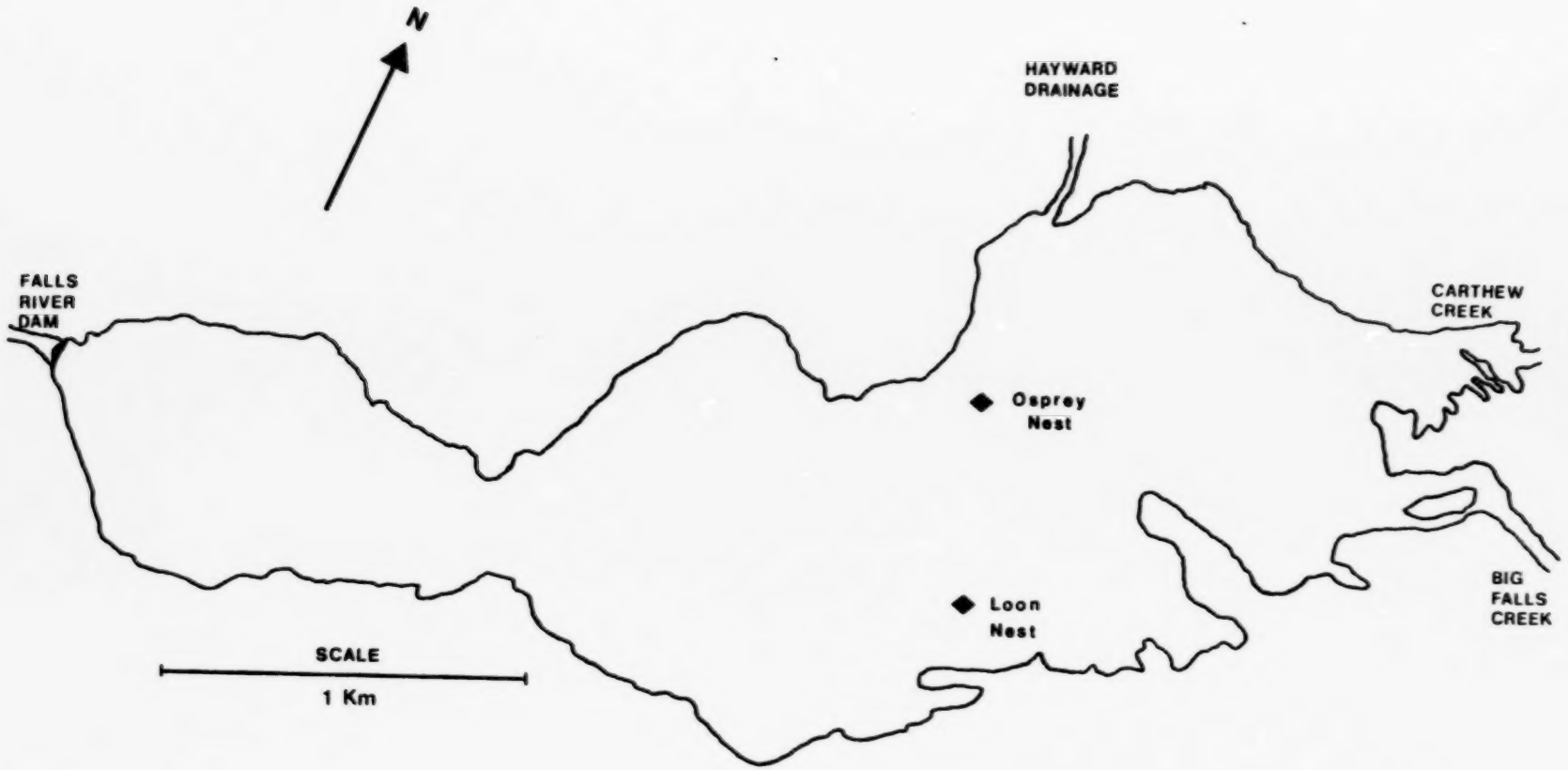


Figure 3 - Location of the Loon and Osprey Nexts Observed in July 1982

3.4 RECREATION

The Falls River reservoir can be reached from Prince Rupert by several water routes. The shortest is 66 km in length via Invermere Passage. A second more exposed route from Prince Rupert is west of Smith Island, into the Skeena estuary. Both routes require navigating up the Ecstall River. Sufficiently large boats (at least 5 m in length) are needed to cross the broad open waters of the Skeena estuary.

At the present time there is no complete road access. There is a forest road within 13 km of the east end of the reservoir, and according to logging plans registered with the B.C. Forest Service, the road will reach the reservoir by 1985. This road however, leads to the south shore of the Skeena River and is isolated from Highway 16 and Prince Rupert.

At the present time, the 430 ha reservoir is not used for fishing or general recreation because of its inaccessibility, and the unattractive and unusable nature of the stump-studded reservoir. At the time of construction of the original dam and generating station (1930), the reservoir was not cleared, leaving dead timbers upright and exposed throughout most of the reservoir. As a result, recreational use of the reservoir for boating (particularly motor boating), fishing or swimming would be limited even if the reservoir were to become accessible.

If the reservoir and selected foreshore areas were cleared in the future, some attractive camping areas might become accessible in the vicinity of the Hayward Lake drainage. Also, the reservoir might be used for sport fishing since some cutthroat trout and Dolly Varden char are present. While there would undoubtedly be some potential for certain types of recreation in a cleared and developed Falls River reservoir, accessibility and the availability of other recreation areas in the region must be considered in evaluating the reservoir.

Prince Rupert residents have access to many water-based recreation resources. Recreational boating and fishing occurs primarily in ocean

waters, most concentrated near Digby, Ridley and Smith islands. Sport fishing and crabbing also take place in the Skeena River estuary. In addition, campground and park facilities are located at nearby Oliver, Diana and Prudhomme lakes. While most outdoor recreation opportunities for the Prince Rupert-Port Edward populations lie within or adjacent to the Tsimpsean Penninsula, some of the tributary valleys of the Skeena (Khtadi, Khyex, Gitnadoix) offer excellent freshwater fishing, hiking and wilderness camping. All of these opportunities are much more accessible and appealing than the Falls River reservoir.

SECTION 4.0 - PROPOSED CLEARING OPTIONS

4.1 CLEARING OPTIONS

The feasibility of several clearing methods have been examined. The underwater logging operation that Alcan is using on the Nechako Reservoir (Alcan 1982) would not be practical because of the large extent of shallow water in the Falls River reservoir and because of the much larger diameter timber to be cleared. Approximately 80 percent of the dense stands of snags occur in water less than 3 m deep (H.M. Larratt Aquatic Consultants Ltd. 1983).

Criteria for clearing (Appendix A) were developed for the purpose of obtaining clearing cost estimates (Appendix A).

Three alternative clearing plans were included in the criteria because the mortality of trees around the reservoir fringe as a result of a new operating regime was an unknown factor. Alternative A assumes no additional loss of live trees as operation of the redeveloped project would be almost identical to the operation between 1970 and 1977. Alternative B assumes a small amount of additional tree mortality around the reservoir fringe as a result of the following water level exceedances predicted in the engineering study (B.C. Hydro 1980b):

Elevation (ft.)	Exceedance
305.0	18.0%
306.0	6.0%
307.5	<0.1%
308.0	-

Alternative B would therefore remove all trees to El. 308.

Alternative C represents the absolute maximum area that could be affected by the new operating regime should tree mortality occur to the limits of the Probable Maximum Flood (El. 313). The rarity and short

duration of flood levels above El. 308 would cause negligible tree damage. This extreme clearing limit should allow some economic return from the standing timber to partially offset the high cost of transporting equipment into the site. This plan would also be compatible with the 5-year logging plan of CIPA Industries Ltd. currently operating in the neighbouring Scotia Creek drainage.

Debris disposal is a significant concern. Stacks of dry snags and trunks were considered a fire hazard so a debris-burning program was incorporated in the clearing criteria. This approach involves clearing one or more burning sites around the reservoir and taking special precautions to avoid accidental forest fires.

The criteria also anticipated that some ecological values might be identified for some stands of trees. Therefore the possibility of bands or islands of uncut and undisturbed trees or snags is incorporated. In addition, some directives are given towards carrying out the clearing without causing undue ecological damage.

The nature of the proposed clearing operations and the scheduling of activities are the two major influences on the impact to water quality and bottom substrates. With an early spring start, the water level in the reservoir would be selectively lowered. As the water level descends, the exposed snags and trees would be cut manually. Once the harvesting has been completed, the water level would be raised and all floatable debris and logs would be boomed and moved by small tug and power skiffs to a disposal site near the dam. A grapple loader would extract the logs from the water and place them on land. A crawler tractor would move the logs to the nearby disposal site for burning. Note that Rae Logging Co. proposed to sort, deck and compact the logs into a neat and acceptable pile for subsequent decay and rot in lieu of burning.

4.2 COST ESTIMATES

Two independent cost estimates have been obtained, although one (Rae Logging Co.) does not adequately address all aspects of the criteria. Key features of each of these estimates are listed below.

1. Rae Logging Company (Appendix B)

   - estimates clearing to El. 313 only
   - does not include burning as it is deemed impossible
   - felling by hand-operated chainsaws
   - proposes decking and compacting disposal piles with a crawler tractor to form a permanent land mass in lieu of burning
   - contractor takes possession of merchantable timber
   - assumes an unrealistic decay rate for decked tree trunks
   - does not address space required for disposal
   - would fell snags in spring as water level is lowered; then as water becomes available after felling is complete would corral snags and floating debris by tugs; would hold debris in booms near the disposal area as removal occurred
   - excludes several essential items from cost estimate, i.e boomstick expense, clearing of timber rooted below El. 290, clearing of disposal sites
   - work completed in 6 to 7 months
   - direct 1982 cost estimate of approximately $556,000 plus extras

2. Hydro Force Construction (Appendix C)

   - estimate based on 95 percent land-based falling and 5 percent from boats in difficult areas
   - work period - 16 weeks
   - no logging equipment in reservoir area; chainsaws used for felling
   - floating debris collected on the surface in booms, towed to a work area and burned
   - location of work area(s) not defined and size not specified

- direct 1982 cost estimates of approximately:

El. 290 to 305	$590,000
El. 290 to 308	$735,000
El. 290 to 313	$879,000

The above cost estimates are direct costs only. True clearing costs would also have to include interest, inflation, corporate overheads, energy loss, and increased debris removal from intakes.

As a comparison, the Alcan work on the Nechako Reservoir has cost approximately $12,345 per hectare. At this rate, the El. 305 alternative (the only alternative which has sufficient water for even a partial barge operation) would cost much more than manual clearing. Caution must be exercised in using this comparative because of the different tree sizes, tree densities, and water depths of the two reservoirs.

SECTION 5.0 - ENVIRONMENTAL EVALUATION

5.1 AQUATIC RESOURCES

(a) Water Quality

Since all snag and tree felling would be completed by hand using power saws and essentially left where fallen until the water level is raised, there would be limited disturbance to the lake bottom. Construction activities would lead to increases in turbidity and suspended solids but these are expected to be insignificant. The spring felling operation would be during periods of high precipitation when elevated natural levels of turbidity and suspended solids are present in run-off waters.

Almost all trees to be harvested below El. 305 are dead as the reservoir has been in existence for some 50 years. Consequently the felling and cutting work would probably generate considerable non-floatable debris. In the shallow water areas, the decaying wood and associated organics would consume oxygen and release organic residues. However, small changes are anticipated considering the high precipitation of the area, the localized nature of the work, and the fact that degradation processes have already been at work for approximately 50 years.

The raising of the water level and collection and booming operations are not expected to significantly change water quality. With proper care and attention to the use of lubricants and fuels for power saws and boats, the chance for spills and contamination of the water should be low.

Minor impacts on water quality would occur due to runoff from the disturbed lands of the offloading area, ramp roadway and disposal sites. During precipitation events, increased levels of turbidity

and suspended sediments would result. The impact would be limited to the immediate proximity of the reservoir adjacent to the disposal site and coupled with dilution and existing background levels of the waters of the reservoir, this impact should not have an adverse effect on aquatic organisms on the bottom.

Steep drainage slopes between the disposal site for debris burning and the reservoir may permit rapid transfer of leachates from the ashes into the lake.

If burning were not carried out, the leachate emanating from the rotting and decaying wood and debris could affect water quality. The concern in this regard would be due to the long term required to reduce the wood to a biodegraded state, and the persistent formation of toxic leachate due to precipitation seeping through the decaying mass. This effect is considered important although probably would not prove to be serious with adequate site preparations to control drainage.

There would be no significant benefit to the water quality of the reservoir which would result from any of the clearing alternatives. The clearing operations would lead to a short-term degradation in water quality although this probably would not be significant if certain mitigation practices were adopted.

(b) Benthic Production

The negative effects of reservoir clearing are divided into long term and short term. The major long-term effect would be the removal of the inundated timber substrate. H.M. Larratt Aquatic Consultants Ltd. (1983) concluded that:

> "The removal of the timber substrate, and the necessary drawdown needed to log the trees, would have a profound effect upon reservoir production. Existing organisms would be lost in the exposed areas because few members of the aufwuchs are capable of moving with receding waters. Little area would remain flooded and be capable

> of contributing recolonizers. ... production would not attain its current levels without the algal substrate provided by the submerged timber."

Another long-term effect would be the loss of the damping effect on wind action. Increased wave motion would stir bottom sediments and increase shoreline erosion. Both of these actions cause turbidity which reduces the zone of light penetration; the zone where the majority of the diatom populations are produced.

The same report identifies two of the short-term impacts. Disturbance of the bottom sediments during clearing operations would promote acceleration of biological oxygen demand (BOD) once re-flooding occurs. The subsequent reduction in bottom oxygen concentrations would reduce the habitat quality for benthic production. Secondly, the disturbed bottom substrate would produce suspended solids which hinder light penetration. This would temporarily reduce light penetration and would cause a concommitant loss in productivity.

There are no foreseen benefits to reservoir productivity as a consequence of reservoir clearing. Tree removal would not have a measurable influence on biological oxygen demand because the decomposition rate of submerged wood is so low.

(c) Fish

Impacts are expected during the following three phases of reservoir clearing. Initially, drawdown would likely lower survival by stranding juveniles on land or flushing juveniles and adults from the reservoir. Secondly, clearing operations would disturb littoral sediments, increase turbidity and decrease survival of juvenile fish. Finally, during the reservoir refilling period and debris removal, sediment disturbances would lead to increased turbidity, resulting in impacts similar to those expected during clearing.

Drawdown may lead to fish being either stranded or flushed out of the reservoir. The forced movement of fish from their preferred habitat to a less productive habitat would lead to increased predation and decreased growth and survival.

During the 3 to 7 months required to clear the reservoir, fish populations distributed throughout the reservoir would be confined and concentrated into an area almost equivalent to the original streambed. Confinement would increase competition, predation and the possibility of fish being flushed from the reservoir. A major portion of the habitat providing food and prey preferred by cutthroat trout would not be available during the clearing operation, hence food might become limiting.

Sediments disturbed by on-land clearing operations and by debris removal are expected to increase turbidity during the refilling period. Reservoir productivity and survival of juvenile fish would decrease as a result.

The removal of timber substrate from the photic zone of the reservoir is expected to reduce primary and secondary production and to remove fish rearing habitat (H.M. Larratt Aquatic Consultants Ltd. 1983). However, the large amount of submerged fallen wood expected to remain on the reservoir bottom would still provide some habitat. In addition, the possible provision of permanent log rafts would help to mitigate this loss. The overall result would be a decrease in the reservoir's carrying capacity for fish as less food and habitat would be available.

Benefits are not expected from reservoir clearing with respect to the fisheries resources in the Falls River reservoir. Clearing would improve the physical and aesthetic aspects of angling but the low fish productivity would not allow much improvement of angling opportunities.

5.2 FOREST RESOURCES

The impacts upon the forest resources were calculated from measurements taken from the forest cover maps of the Ministry of Forests, and from information given in the map area volume statements.

Clearing of the area between El. 290 and 305 would not require the felling of any live trees as operation of the redeveloped project would be almost identical to that between 1970 and 1977 (Section 4.0). Clearing of the area between El. 290 and 308 would involve felling live trees growing on approximately 57 ha of land between El. 305 and 308 (Table 5-1). This would include a strip approximately 2 m wide for each of the steep shoreline types and removal of about 3850 m^3 of timber adjacent to the Carthew and Big Falls creeks. Clearing of the area between El. 290 and 313 would involve felling live trees growing on about 109 ha of land between El. 305 and 313. This area would include a strip approximately 5.5 m wide for each of the steep shoreline types and would remove about 52 255 m^3 of timber adjacent to the Carthew and Big Falls creeks.

The commercial timber stands in the valleys of the Carthew and Big Falls creeks are included in the present 5 year logging plan of CIPA Industries. The same company has also applied for cutting rights in the Hayward drainage area.

The expected flood exceedances of 6 to 18 percent for the area between El. 305 and El. 306 would result in tree mortalities between these levels. This conclusion assumes that the exceedances would be semi-continuous and occur during the spring or summer months. Based on the same assumption, flood exceedances of less than 1 percent (i.e. less than 4 days/year) for the 307.5 ft. level and a nondeterminate percentage for the 308 ft. level, would not likely cause any tree mortalities. However this judgement may not be valid for western hemlock, a shallow-rooted species intolerant of flooding (Brink 1954) or for red alder regarded by Brink (1954) as one of the most intolerant of all trees to flooding. Therefore if dam redevelopment proceeds,

TABLE 5-1

FORESTRY IMPACTS OF CLEARING ALTERNATIVES

Type*[1]	Volume m^3/ha	El. 305-308 area (ha)	El. 305-313 area (ha)	El. 305-308 volume (m^3)	El. 305-313 volume (m^3)
CCyH 931-P	385.5	0.2	0.5	71.1	193.5
CHB 941-P	510.3	0.8	2.0	381.4	1 037.3
HB 941-P/M	803.4	0.2	0.6	179.4	488.0
HBC 941-P	752.3	0.6	1.6	452.7	1 231.5
SH 961-G	979.3	3.9	53.4	3 848.7	52 255.5
Alpine Forest	-	0.0	0.1	-	-
Slides	-	0.1	0.2	-	-
Swamp	-	50.9	50.9	-	-
TOTAL	-	56.7	109.3	4 933.3	55 205.8

*1 Type codes show: species-age-height-stocking-site class

Species: C - western red cedar
Cy - cypress (yellow-cedar)
H - western hemlock
B - balsam (Pacific silver fir)
S - Sitka spruce

Age code: 9 - older than 251 years

Height code: 3 = 19.5 to 28.4 m
4 = 28.5 to 37.4 m
6 = 46.5 to 55.4 m

Stocking code: 1 represents more than 76 trees/ha

Site: P = poor, M = medium, G = good

clearing Alternative B would be most desirable because it would ensure the recovery of timber in the three creek valleys at the inlet of the reservoir. Work should be integrated with the harvesting operations of CIPA Industries. The logistics of clearing a 2 m wide strip around the steep shoreline would probably preclude the recovery of potentially commercial material.

The benefits to the forest resource of a clearing operation would be the recovery of timber along the Carthew and Big Falls creeks and the Hayward Lake drainage. However these timber stands are expected to be logged even if the redevelopment project does not proceed. The only additional benefit would be the provision of approximately 60 man-months of employment to forestry personnel involved in the clearing operation.

5.3 WILDLIFE

Reservoir clearing would have a minor effect on wildlife resources. Two specific concerns are the osprey and the loon, as both species have a high aesthetic value and are not adundant in British Columbia. Removal of submerged debris may cause a small reduction in food production for fish and may therefore result in slight declines in food availability for both bird species. Complete reservoir clearing would eliminate the nesting habitat for both species and would thereby eliminate them both from the reservoir area. Preservation of small areas with snags retained should reduce any permanent effects of disturbance and allow both species to continue living on the reservoir. The Fish and Wildlife Branch support the recommendation that these habitats be protected (A. Edie, pers. comm.).

An earlier concern, supported by the Fish and Wildlife Branch, that cavity-nesting waterfowl populations might be affected was not borne out because of the absence of suitable nest sites.

Ideally, clearing activities should not commence in the reservoir until after both species have fledged their young. This would probably not be until late August and therefore is not likely a practical limitation. As a result, at least one year's production of young would be jeopardized. Feeding habitat for both species would be lost during the clearing operation drawdown. Future production would also be lost should either parent decide to abandon the reservoir.

The nesting of the common merganser would be affected if clearing were extended to either the 308 or 313 foot level but would not be affected by removing dead trees or snags. The merganser nests as high as possible in the cavities in living trees. The hatchlings, anywhere from 6 to 16, plunge forth immediately and tumble up to 20 m to the soft forest floor below.

No conceivable benefits would accrue to the wildlife resource as a result of any clearing option.

5.4 RECREATION

The effect of the proposed Falls River development, including reservoir clearing, would be to improve the recreation capability. The lake would be made more suitable for boating, and selected areas of shoreline would have potential for campground development. Even with standing trees removed, the shallow nature of the reservoir and the stumps and sunken debris would make it unattractive for motor boating or swimming. Sport fishing would be more amenable since the cleared reservoir would permit boat access throughout. Physical access to the reservoir is a limitation. A boat large enough to navigate the Skeena and Ecstall rivers is too large to transport the 100 m vertical rise to the reservoir. A boat small enough to transport is too small to use as access to the site. Therefore, given the remoteness, difficult public access, and the availability of recreational opportunities in the Prince Rupert area, there would not be much increase in demand for recreation at Falls River if it were developed.

This assessment has also been voiced by Regional District and Ministry of Lands, Parks and Housing planners (W.K. Lindsay, Skeena Rupert Regional District; R. Dalziel, Ministry of Lands, Parks and Housing; pers. comm.). They suggested that there are many more accessible resources in the region that could be developed for recreational use and that reservoir clearing at Falls River would not attract recreational users to the site.

Reservoir clearing would have a small net benefit to the recreational capability of the Falls River resources. The two lower clearing options would have the effect of making the reservoir appear more like a natural lake, as well as improving the utility of the reservoir for recreation. Clearing to the 313 level would leave an unnatural shoreline devoid of mature trees, with no additional improvement of recreational capability. However, given the inaccessibility of the reservoir and the abundance of other recreation resources in the region, it is unlikely that this reservoir would be used extensively.

SECTION 6.0 - MITIGATION OPPORTUNITIES

The environmental evaluation highlighted both the negative and positive effects that reservoir clearing would have on each discipline. Through this process, numerous opportunities for reducing environmental degradation during clearing became apparent. These opportunities are included in this report as a basis for future consideration.

1. Debris

Accumulation of considerable amounts of non-floatable debris would create an unpleasing appearance to the shore and bottom of the shallow areas of the reservoir. Therefore the felling operation should be monitored so that if considerable non-floatable debris is generated, consideration can be given to having work parties manually collect and compact this debris in local above-water disposal sites. This may also help to lessen nuisance problems associated with small floatable debris at the dam and power intakes.

2. Snags and Trees

The general appearance of the reservoir, particularly shallow areas, would be improved if all snags and trees are cut as flush to the ground as possible. An environmental area of uncut and undisturbed trees or snags (Fig. 4) around the nest sites of the osprey and loons would preserve their habitat. In total, this area is small and would not represent a significant cost reduction.

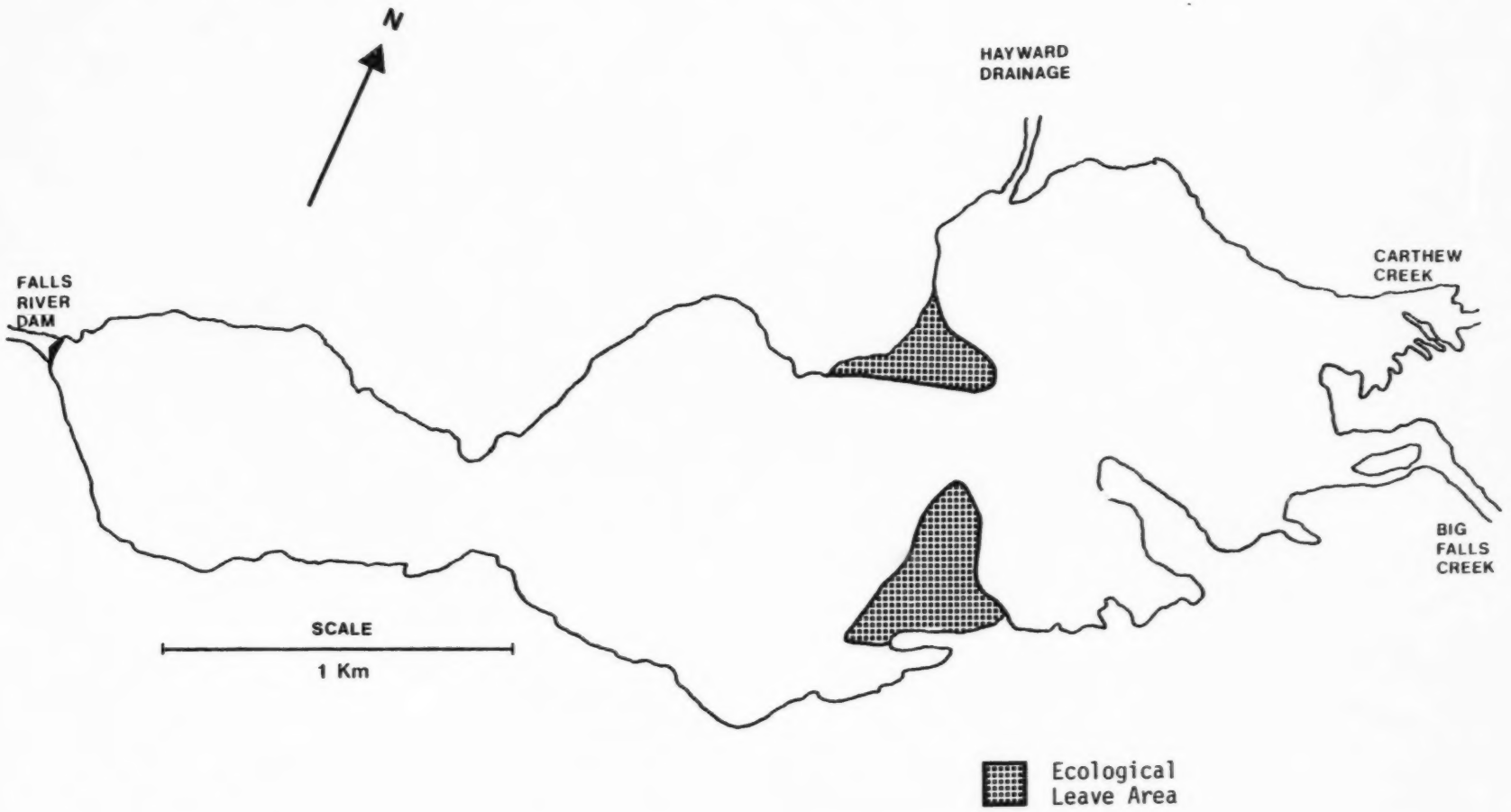


Figure 4 - Location of Ecological Leave Areas Where Trees Should Remain Uncut

3. Timing

The extent and duration of the harvesting operation should be kept to a minimum. It may prove feasible to have the contractor employ a few more people to limit the time spent on the operation.

4. Contaminants

A preventative clause pertaining to the use of oil and grease (fuel and lubricants) and their storage should be included in all contractual documents to ensure that their use, disposal and spillage does not endanger the environment.

5. Disposal Site Preparation

Appropriate site preparations should be carried out to develop a suitable loading deck at the water's edge to limit bottom-scouring as logs are removed from the water. In addition, the ramp leading from the water to the disposal site should be prepared if possible, by scraping away most surface soil and vegetation thereby exposing bedrock and heavy gravel. This preparation would help to limit erosion and associated contamination of runoff water. The exposed substrate would better support the heavy traffic of the tractor crawler and logs from the water to the disposal site.

6. Disposal Permits

The disposal site should be field inspected prior to clearing work to ascertain the best management of the site. Operational guidelines for the withdrawal of the refuse logs to the disposal site should be developed and made part of the contractual agreement with the logging contractor. Regular monitoring should be carried out to ensure that good practices are being employed. Generally, the disposal site should be well away from any watercourse and at least 1.5 m above the groundwater level.

Surficial top soil and vegetation should be removed to the perimeter of the site to allow peripheral surface drainage to circumvent the site. The area within the boundaries of the site should be contoured to permit easy drainage for surface runoff. An adequate buffer zone should exist around the site so that leachate from the site will be adequately distributed and diluted before reaching the reservoir. The logging contractor should be required to obtain necessary refuse disposal permits for the work and ensure compliance with the requirements of the permits. Finally, cleanup, backfilling, and restoration of the site should commence immediately upon completion of the salvaging operations.

7. Fire Prevention

The disposal areas should be sufficiently large to prevent the escape of fire. Pumps and fire hoses should be kept on standby at any time burning is in progress.

8. Log Rafts

The reduction of benthic production could be partially offset if rafts of floating logs were anchored in a few spots. These rafts would also partially replace the loss of shelter habitat for fish. These rafts may eventually develop a surface vegetation suitable for use by loons or other birds.

SECTION 7.0 - CONCLUSIONS

The environmental values associated with reservoir clearing are not highly positive or negative. Recreation is the only resource where there might be a benefit. Capability for motor boating and fishing would increase. However, difficulty of access to Falls River and the existence of numerous alternative and better resources for the same type of recreation indicate that demand would not grow enough to justify the clearing work. The clearing activity itself would provide a slight social benefit by the employment generated.

Forestry effects are almost neutral. The harvest of two merchantable patches of timber could be advanced by a few years due to reservoir clearing but the net effect of this advancement is considered negligible on the forest resource or industry.

All three aspects of aquatic production would experience negative effects. Water quality would be degraded for a short period following clearing; benthic production would suffer long-term decreases; and the quality of fish habitat would decline as a consequence of the loss of both food and shelter. Wildlife populations of two highly aesthetic bird species, the loon and osprey, would be subjected to small losses.

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APPENDIX A

FALLS RIVER RESERVOIR CLEARING CRITERIA

APPENDIX A

FALLS RIVER RESERVOIR CLEARING CRITERIA

Detailed Specifications

Scope of Work

To cut and dispose of by salvage or burning all standing trees and snags in the designated reservoir area, and to dispose of all floating wood in that area.

Alternative Clearing

The Tenderer shall quote a price for the following alternative areas of clearing, and upon award of the contract shall carry out the clearing of the alternative area directed by the Engineer in accordance with this specification.

Alternative Area A

The area bounded by the ground contours at El. 290 and 305.

Alternative Area B

The area bounded by the ground contours at El. 290 and 308.

Alternative Area C

The area bounded by the ground contours at El. 290 and 313.

The approximate reservoir area at various elevations is as follows:

El. 290	325 acres
El. 305	1090 acres
El. 308	1230 acres
El. 313	1360 acres

Elevations are given in feet of local datum which is approximately 83.5 feet above geodetic datum.

Information to be Provided by Tenderers

Tenderers shall state the work force equipment and the methods to be used in reservoir clearing. They shall provide with their tenders, drawnings showning proposed disposal areas, and location and extent of any area outside of the clearing boundaries which they propose to clear and utilize for burning purposes, including fire guards in accordance with B.C. Forest Service requirements.

Detail Specification

The Contractor cut all trees and snags in the reservoir between the elevation listed for each alternative above.

All trees and snags shall be cut off one tree diameter above the ground uphill side.

Bands or islands of trees may be left uncut and undisturbed as directed by the Engineer. These will amount to approximately 1/10 of the maximum area of the alternative, and the price shall contain an optional reduction for these to be left uncut.

Debris Disposal

All material which floats when the reservoir is raised to full alternative level shall be removed to one or more disposal areas, and piled and burned at the appropriate time. The disposal area shall be approved by the Engineer prior to commencement of piling, and a perimeter fireguard of width required by the B.C. Forest Service shall be cleared of all combustible material to prevent damage to adjacent trees and the spread of the fire. The disposal area shall be cleaned up and left in a clear, neat condition upon completion of the work.

Reservoir Level Control

During the work, the reservoir elevation will be controlled by the Authority's operating staff as far as weather conditions permit. The level can be drawn down to El. 290 for several days. All requests for reservoir level changes must be made at least 2 weeks before start of change.

Salvage

Merchantable logs over 18" at the butt shall be separated and assembled in a boom. If no buyers are obtained within 2 weeks of booming, the material shall be burned.

Permit

All burning shall be done in accordance with B.C. Forest Service regulations and approval, and all necessary permits will be obtained by the Contractor. The Contractor shall be wholly responsible for the provision of suitable and adequate firefighting crews and equipment, and all costs of fighting fire arising from his action or negligence shall be borne by himself.

Preservation of Flora and Fauna

The Contractor shall:

1. Refrain from destroying, removing, or clearing trees, timber, and shrubs to an extent greater than necessary for the execution of his work.

2. Prevent unnecessary disfigurement of the reservoir area and the countryside. In particular, gouging or tracking of the reservoir bottom or fringes shall be avoided.

3. Take such measures as are necessary to prevent his employees from illegally hunting, disturbing, capturing, or destroying any animals, birds, or fish.

JPW/mt

5 January 1982

Original initialled by JPW

APPENDIX B

ESTIMATE AND PROCEDURES FOR RESERVOIR CLEARING

SUBMITTED BY RAE LOGGING LIMITED

1. To cut and dispose of by salvage or piling all standing trees and snags in the lake and remove all floating debris from the same.

   Any burning of material from the lake will not be done by the Contractor.

2. All dead snags and trees will be removed to a water level of 313 feet.

3. Work force will be approximately five to seven employees.

   - 1 Graple Loader to lift wood from lake
   - 1 steel tug to tow debris to site
   - 2 small power skiffs and outboard to assist tug in cleanup
   - 1 Cat to push debris from loader to back of landing
   - 4 to 6 powersaws for falling and bucking debris
   - 60 boomsticks to corral and tow material

   As discussed with Mr. K. Arnold-Smith, the large area to the left of the dam could be used to pile debris. This would be the only area used. The Contractor will not burn debris as it will be very wet and require a lot of time to dry.

4. OK.
   The price has been deducted from the estimate for bands of islands and trees to be left.
   In my conversation with Mr. K. Arnold-Smith, we felt there was not enough water to float out material from Carthew, Big Falls, and Hayward Creek, so these areas were excluded. When the job is completed, boomsticks could be put across these areas to contain any fall down at a later date.

5. Burning is almost impossible. All debris will be removed.

6. During the falling of these snags and trees, if the water was drawn down to 280 feet most of the area can be reached by walking. If water is 290 feet, some areas are under water and falling of snags from a boat is very costly.

7. Any logs which were merchantable shall become the responsibility of the Contractor for removal and sale.

8. Burning of this wet wood would be virtually impossible as most has been in the water for fifty years.

This bid is only to remove debris from the lake. Fall, buck, and remove the same from the areas enclosed in RED. This does not include Hayward, Carthew and Falls creeks. If these are to be included, a revised bid will be made. Any trees that have to be felled out of a boat will be charged $100.00 per tree. This is very dangerous and time consuming. A separate price for burning, if required, will be charged. Approximately 60 boomsticks will be needed to move debris. Boomsticks are an extra charge. An extra charge will be made if the storage area for debris is not big enough and another site has to be made. Moving of equipment into the

site will be done by the Contractor. The Contractor shall have the use of the Hydro camp for the job.

In the case of extra work being done such as installing boomsticks around the lake at the creeks and in front of the dam, will be an extra if required.

I have taken some pictures when the lake was drained to 280 feet. You can see the dry areas and areas that have to be felled from a boat. The bid that I have arrived at is a 1982/83 price. If this is done at a later period an increase of 8 to 10 percent will be added to the total price. I think this job will take about 6 to 7 months. Debris which does not float when lake is flooded will be left.

TOTAL BID - $556,473,28

Original signed by Norman J. Rae.

APPENDIX C

ESTIMATES AND PROCEDURES FOR RESERVOIR CLEARING

SUBMITTED BY HYDRO FORCE CONSTRUCTION

inter-office memo

MEMO TO: W.N. REA 4 March 1982

FROM: P.C. LLEWELLYN

SUBJECT: Falls River Reservoir Clearing

Attached please find our estimates to carry out clearing of the Falls River Reservoir.

The costs are based on the detailed specification. It should be noted that an on site inspection was not possible due to winter conditions however, we feel that the information assembled from areial photos and drawing no. 908-C14-D70 is sufficient in 1982 dollars to complete the work.

The period of effort would be approximately 16 weeks. The work force would consist of-

1 Foreman
2 Sub Foremen
2 Boat Operators
1 Machine Operator
6 Power Saw Operators
8 Helpers

Major Equipment

35 Ton Track Mounted Crane with 70ft. boom and log grapple.
Shallow Draft Tug Boat (maximum 4 ft.).
2 Aluminum Boats 16 ft. with outboard motors of approximately 20 H.P.
6 Power Saws with bars and chains and tools.

The estimates are based on 95% land falling and 5% from boats in difficult areas. This of course will require reservoir water level control to elevation 290. No logging with equipment in the reservoir basin is anticipated. Felled timber and debris which float will be collected on the surface in booms, towed to the work area, vacated by the Dam Construction forces and burnt.

Account no. 825 can be substantially reduced if the construction camp can be used for accomodation.

P.C. Llewellyn

PCL/eb

10507 (80/11)

ESTIMATE OF CONSTRUCTION COSTS

Date 18 Feb. 82

PROJECT Falls River Project
Reservoir Clearing Alternative "A"
Elevation 290-305

G.W.O.# _____

Prepared By B. Kopp

COST ACCT. NO.	ACCOUNT DESCRIPTION	QUANTITY	UNIT DESC.	M/H	LABOUR	MATERIAL	EQUIP.	OTHER	TOTAL COST	UNIT COST
	Directs									
	Falling Trees & Snags	1	Unit	9400	160000			54000	214000	
	Towing Debris	1	Unit	2258	38400	5000	15360		58760	
	Bailing & Burning	1	Unit	3648	62000		14000	81000	157000	
				5306	260400	5000	29360	135000	429760	
	Common Services									
800	Supervision							21280	21280	
810	Material Handling			105	1575	500			2075	
815	Consumables & Small tools					3000	1000	1000	5000	
820	Communications							1000	1000	
825	Moving men and equipment			450	7650			25000	32650	
830	Living Expenses	1600	M/D					96000	96000	
835	First Aid & Safety			124	2108	250		200	2558	
				679	11333	3750	1000	144480	160563	
	Directs			15306	260400	5000	29360	135000	429760	
	Common Services			679	11333	3750	1000	144480	160563	
	TOTAL			15985	271733	8750	30360	279480	590323	

ESTIMATE OF CONSTRUCTION COSTS

Date 18 Feb. 82

PROJECT Falls River Project
Reservoir Clearing
~~Alternative "B" Elevation 290-308~~

G.W.O.#

Prepared By W. Kopp

COST ACCT NO	ACCOUNT DESCRIPTION	QUANTITY	UNIT DESC.	M/H	LABOUR	MATERIAL	EQUIP.	OTHER	TOTAL COST	UNIT COST
	Directs									
	Falling trees & Snags	1	Unit	12000	204000			67500	271500	
	Towing Debris	1	Unit	2823	48000	5000	19200		72200	
	Bailing & Burning	1	Unit	5647	96000		18000	102000	216000	
				20470	348000	5000	37200	169500	559700	
	Common Services									
800	Supervision							26400	26400	
810	Material Handling			105	1575	500			2075	
815.	Consumables & Small tools					3000	1000	1000	5000	
820	Communications							1250	1250	
825	Moving men and equipment			450	7650			25000	32650	
830	Living Expenses	1740	M/D					104400	104400	
835	First Aid & Safety			124	2108	250		200	2558	
				679	11333	3750	1000	158250	174333	
	Directs			20470	348000	5000	37200	169500	559700	
	Common Services			679	11333	3750	1000	158250	174333	
	Total			21149	359333	8750	38200	327750	734033	

10507 (80/1)

ESTIMATE OF CONSTRUCTION COSTS

Date 18 Feb. 82

PROJECT Falls River Project
Reservoir Clearing
~~Alternative "C" Elevation 290-313~~

G.W.O.#

Prepared By W. Kopp

COST ACCT. NO.	ACCOUNT DESCRIPTION	QUANTITY	UNIT DESC.	M/H	LABOUR	MATERIAL	EQUIP.	OTHER	TOTAL COST	UNIT COST
	Directs									
	Falling Trees & Snags	1	Unit	14588	248000			83700	331700	
	Towing Debris	1	Unit	3388	57600	5000	23040		85640	
	Bailing and Burning	1	Unit	6776	115200		21600	122400	259200	
				24752	420800	5000	44640	206100	676540	
	Common Services									
800	Supervision							31680	31680	
810	Material Handling			105	1575	500			2075	
815	Consumables & Small tools					3000	1000	1000	5000	
820	Communications							1500	1500	
825	Moving men and equipment			450	7650			25000	32650	
830	Living Expenses	2104	M/D					126240	126240	
835	First Aid & Safety			140	2380	250		200	2830	
				695	11605	3750	1000	185620	201975	
	Directs			24752	420800	5000	44640	206100	676540	
	Common Services			695	11605	3750	1000	185620	201975	
	TOTAL			25447	432405	8750	45640	391720	878515	